INDOOR AIR QUALITY ASSESSMENT

Westford Town Hall
55 Main Street
Westford, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of Darren R. MacCaughey, Director of Environmental Services for the Westford Board of Health, an indoor air quality assessment was done at the Westford Town Hall (WTH), 55 Main Street, Westford, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Center for Environmental Health's (CEH) Bureau of Environmental Health Assessment (BEHA). The investigation was prompted by employee concerns about odors in areas around windows and along the south and west walls of the building. On May 7, 2004, Michael Feeney, Director of Emergency Response/Indoor Air Quality (ER/IAQ), made a visit to this building.

The WTH is a two-story, clapboard building located in Westford Center. The date of construction is estimated to be circa 1870. The building was reportedly renovated in the 1970s and again in the 1990s. The 1990s renovation subdivided the second floor auditorium, reconfigured office space on the first floor and installed a heating, ventilating and air-conditioning (HVAC) system on the first and second floors. Sash window systems were openable throughout the building at the time of the assessment.

Building occupants reported plastic/rubber like odors after the installation of storm windows and painting of the WTH exterior. The odors were reportedly most prevalent in office areas located on the south and west walls of the WTH where direct sunlight warms the exterior walls of the building. Odors are noted once the sun starts to warm exterior walls and increase or decrease during the day depending on the amount of sunlight exposure to the exterior wall/window frames. After interviewing a number of building occupants, it was clear that occupants in offices on east and north walls have not

experienced odors, despite direct sunlight exposure to the eastern walls during the morning.

The Town of Westford hired Cashins & Associates, Inc. (CAI), an environmental consultant to identify the source of the odor. CAI ruled out the following possible sources of the odor:

- The presence of water or mold in the wall.
- Elevated volatile organic compounds (VOCs) in the building.
- Odors being generated from outside and drawn into the building via the HVAC system.
- Elevated VOC's from carpeting.
- Odors from wall cavities (CAI, 2004).

Based on these observations, CAI suggested an examination of the paint that was applied to the exterior at the same time as the storm window installation (CAI, 2004).

Methods

BEHA staff performed visual inspection of building materials for water damage and/or microbial growth. Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for ultrafine particulates (UFPs) were taken with the TSI, P-Trak ™ Ultrafine Particle Counter Model 8525. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID).

Results

The WTH has an employee population of 30 with approximately 100 members of the public visiting daily. The tests were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the tables that the carbon dioxide levels were below 800 parts per million (ppm) in all areas surveyed, indicating adequate ventilation. However, it is important to note that the sole source of fresh air in the building during the assessment resulted from air penetrating through cracks and seams around window frames and the periodic opening of exterior doors.

There are two heating, ventilation and air conditioning (HVAC) systems in the building, both of which were deactivated during the assessment. One air-handling unit (AHU) is installed in the basement that services office space on the first floor. Air is distributed by floor diffusers connected to ductwork. A second AHU in the attic services the second floor. This system is connected by ductwork to ceiling mounted air diffusers.

In order to have proper ventilation with a mechanical supply and exhaust system, these systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 ppm. Workers may be exposed to this level for 40 hours/week based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see Appendix A.

Temperature readings ranged from 73^{o} F to 79^{o} F in occupied areas, which were very close to the BEHA recommended comfort guidelines. The BEHA recommends that

indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Temperature control is often difficult in an old building without the ventilation systems functioning as designed (e.g., deactivation of AHUs).

Relative humidity measurements ranged from 35 to 40 percent, which were close to the lower end of the BEHA comfort range. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Several offices contained plants. Plant soil, standing water and drip pans can be a potential source of mold growth. Drip pans should be inspected periodically for mold growth and over watering should be avoided.

Other Concerns

In an effort to identify odors, air testing for TVOCs and UFPs was conducted. Indoor air quality can be negatively influenced by the presence of materials containing VOCs. VOCs are carbon-containing substances that have the ability to evaporate at room

temperature. Frequently, exposure to low levels of VOCs may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. Outdoor testing was conducted for comparison to indoor levels. Outdoor TVOC concentrations were non-detectable or ND (Table 1). Indoor TVOC concentrations were also ND.

The measurement of airborne particulates can be used to pinpoint the source of pollutants. Measurements for UFPs [particles measuring 0.02 micrometers (μm) to 1 μm in diameter] were taken. Particulate matter that is of a small diameter (<10 μm) can penetrate into the lungs and subsequently cause irritation. For this reason a device that can measure particles of a diameter of 10 μm or less was used to identify pollutant sources. The instrument used by the BEHA to conduct air monitoring for UFPs counts the number of particles that are suspended in a cubic centimeter (cm^3) of air. This type of air monitor is useful as a screening device, in that it can be used as a tracker to identify the source of airborne pollutants by counting the actual number of airborne particles. The source of particle production can be identified by moving the ultrafine particle counter (UPC) through a building towards the highest measured concentration of airborne particles. Measured levels of particles/cm^3 of air increase as the UPC is moved closer to the source of particle production. While this equipment can ascertain whether unusual sources of ultrafine particles exist in a building or that particles are penetrating through spaces in doors or walls, it cannot be used to quantify whether the NAAQS PM_{10} standard was exceeded. The primary purpose of these tests was *to identify potential pollutants.*

Air monitoring for UFPs was conducted in offices around window frames and other areas where odors were detected. For comparison, outdoor measurements were also conducted. Indoor and outdoor levels of UFPs were comparable and not conclusive of an unusual source of UFPs within the WTH.

While air sampling did not identify pollutants of concern, interviews with building staff and the examination of both the window systems and the exterior of the WTH provided clues to the likely source of the odors. As mentioned previously, WTH staff along the west and south walls consistently reported odors in their work areas during sunny days when direct sunlight strikes the window frames of the building. BEHA staff also detected a rubber-like (new car tire) odor initially in the southeast office on the second floor (Collins office). The odor was stronger along the southern wall and subsequently in office areas along the west wall on both the first and second floors as the sun rose toward high noon.

Of note was the lack of detectable odors in the financial director's office (the southeast corner office on the first floor) and the town accountant office (center work area on the first floor) at the same time odors were detected in second floor areas above these offices. All other south and west wall offices on the first and second floors had detectable odors simultaneous to when sunlight struck the windows (Pictures 1 through 3). These odors were particularly strong in offices with closeable doors (Collins and MacCaughey offices). BEHA staff examined the exterior of the building and noted that the two office areas without odors did not have new storm windows. The financial director's office south wall window does not have a storm window (Picture 4). The window for the town accountant office is an old, aluminum frame (the type of storm

window that was replaced elsewhere) and is located within a foyer behind a vending machine (Pictures 5). All other offices areas along the south and west exterior walls are equipped with storm windows installed three years ago.

Based on these observations, the odors are likely related to the new window frames. The installation of these storm windows appears to have not been optimal. Visible light could be seen around frames, and gaps in window caulking were evident. In this condition, water exposure to the interior of the window frames is likely. The odors may be associated with exposure to driving rain. Moist weather tends to travel in a northeasterly track up the Atlantic Coast towards New England (Trewartha, G.T., 1943). Wet weather systems generally produce south/ southwesterly winds, which will expose the south and west facing walls to driving rain on a consistent basis, unlike the east and north walls where no odor was reported. Excessive exposure to moisture may have allowed water to penetrate into storm window frames, which are likely to contain a rubber-like material. Once water accumulates inside the window frame, it is exposed to the rubber-like material and may acquire the odor of the material. When the window frames are heated by sunlight, a vapor may be produced that creates this rubber-like odor.

Exposure of the window areas to moisture appears to be key, since building occupants on the east and north walls did not report the presence of these odors. The north and east wall would be exposed to direct rainfall infrequently. In addition, WTH staff near east walls did not report odors when window frames are heated by direct sunlight during the morning. As previously noted, the financial director's office on the first floor in the southeast corner of the building has two windows, one in the east wall and the other in the south wall, yet no odors were reported in this office. This particular

office is different from all other offices with the odor, since it does not have a storm window on its south wall. Based on these observations, the window frames appear to be the most likely source of reported odors.

Conclusions/Recommendations

Information gathered through air testing did not identify pollutants of concern within the WTH. Based on interviews of WTH building occupants and examination of the building components, it appears the odor is most likely to be related to meteorological conditions and the storm window installation. In view of the findings at the time of this visit, the following recommendations are made:

1. As a test, remove one window frame from an office with a closeable door (Collins office). If the odor is not present in the test office after a rainstorm followed by a sunny day, consideration should be given to the removal of storm windows on the south and west wall.
2. If the odor is still present in the test office after removal of the storm window, examine whether a rubber-like material was installed in the original window frame of the test office. Remove such material if present. If the odor is not present during sunny days in the test office, after the rubber-like material is removed, it is recommended that all rubber-like window materials on the south and west wall be removed/replaced.
3. If the odor is still present in the test office after removal of the storm window and rubber-like material, examination of the paint on window frames and exterior walls should be examined. Removal of the paint on widow frames and around seams of the window frame may be necessary.

4. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
5. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Consider reducing the number of plants in offices.

References

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Picture 1

West Wall Windows of WTH

Picture 2

South Wall Windows of WTH

Picture 3

Close Up Of West Wall Window with Storm Window

Picture 4

Picture of First Floor Southeast Corner Office, Note the Lack of A Storm Window

Picture 5

Window in Foyer Behind Vending Machine, Note Frame Is Unpainted Aluminum, Unlike Newly Installed Storm Windows.

TABLE 1
Indoor Air Test Results – Westford Town Hall, Westford, MA
May 7, 2004

Remarks	Carbon Dioxide (*ppm)	TVOC (*ppm)	Temp. (°F)	Relative Humidity (%)	Ultrafine particles (particles per cc of air in thousands)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Outside (Background)	388	ND	80	32	12					
Electrical inspector	602	ND	77	36	16	0	Y	Y	Y	Ventilation system off
Permitting office	534	ND	77	37	16	3	Y	Y	Y	Ventilation system off
MacCaughley Office	560	ND	77	37	20	0	Y	Y	Y	Ventilation system off Odor detected during sampling Sunlight on south wall
Building Inspector	627	ND	77	37	16	1	Y	Y	Y	Ventilation system off Odor detected during sampling Sunlight on south wall
FAX room, BOH	626	ND	77	36	17	0	N	Y	Y	Ventilation system off
Collins office	689	ND	79	35	16	0	Y	Y	Y	Ventilation system off Odor detected during sampling Sunlight on south wall

***ppm = parts per million parts of air**
ND = non detectable

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

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								Supply	Exhaust	
Board of health nurse	645	ND	79	36	16	1	N	Y	Y	Ventilation system off
Mail room	630	ND	78	35	16	2	N	Y	Y	Ventilation system off
Map room	642	ND	78	35	16	1	Y	Y	Y	Ventilation system off
Town planner	658	ND	78	35	16	1	Y	Y	Y	Ventilation system off
Town manager reception	787	ND	77	35	16	2	Y	Y	Y	Ventilation system off
Town manager office	787	ND	77	36	16	0	Y	Y	Y	Ventilation system off
Human resources	600	ND	75	36	18	1	Y	N	Y	Ventilation system off Plants
Mens rest room	551	ND	73	39	19	0	Y	Y	Y	Ventilation system off
Tax collector	743	ND	75	39	15	4	Y	Y	Y	Ventilation system off Ceiling fan Front area open to hallway

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								Supply	Exhaust	
Town accountant private office	759	ND	74	38	15	1	Y	Y	Y	Window open Ventilation system off Odor detected
Town accountant area	706	ND	73	40	19	2	Y	Y	Y	Ventilation system off
Financial director private office	662	ND	76	37	16	1	Y	Y	Y	Ventilation system off
Assessors office	636	ND	76	38	15	3	Y	Y	Y	Window open Ventilation system off Front area open to hallway
Assessors private office	635	ND	76	38	16	2	Y			Window open Ventilation system off
Town clerk	631	ND	76	38	14	1	Y			Window open Ventilation system off Front area open to hallway

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